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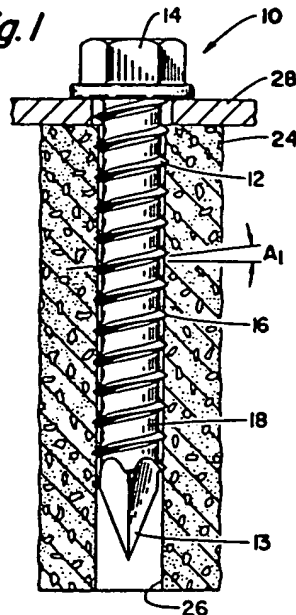(56) Documents cited
None

(58) Field of search
B3N
F2H

(54) A method of securing a screw anchor in masonry

(57) A threaded fastener 10 for anchoring embedment into masonry structures and particularly into masonry structures 24 which include relatively hard aggregate is inserted with a rotational speed not exceeding 250 RPM at torque levels not less than 150 in.lb. (1700 cmN). The fastener 10 preferably has a shank with a spaced, helical, continuous thread 2 extending from the entering portion 13 towards the enlarged head portion 14 for a substantial portion of the length of the shank, the helical thread having a V-shaped cross-sectional configuration with the flanks of the thread intersecting at an included angle A, in the range of 50° to 65°; the helical thread extending about the shank at a lead angle A, in the range of 6° to 8.5° and the ratio of bore diameter/thread crest diameter being substantially 0.9 to 1.
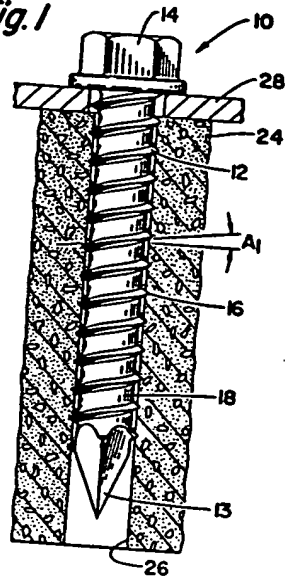
Fig. 1
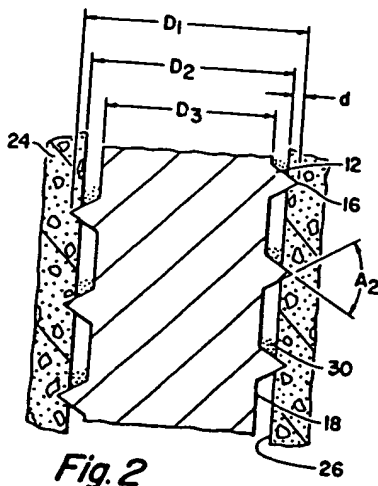

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Fig. 1

Fig. 2

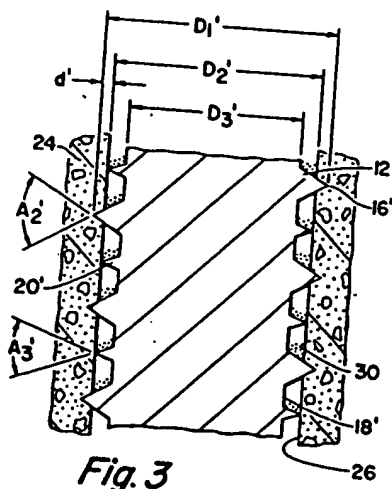**Fig. 3**

SPECIFICATION

A method of securing a screw anchor in masonry

5 The present invention relates generally to a method of securing a screw anchor within a bore formed in a masonry or concrete structure which includes relatively hard aggregate.
   The securement of devices, attachments, fixtures etc. to masonry structures has typically used stud-like devices which are inserted in a bore or hole preformed in the masonry. The stud-like anchor must in some way be activated to create a wedging or slight embedment within the walls
10 of the masonry to properly provide suitable pull-out strength in such applications. Recent advances in the art of securement to masonry structures have included screw threaded type anchors which are screwed directly into the walls of a bore in the masonry or concrete. Examples of these screw anchors are shown in patents such as U.S. Patents Nos. 3,902,399 and 3,937,119.
15 While anchors and method of installing them as generally described in these prior art patents may be suitable for some compositions of masonry or concrete, it has been found that certain geographical areas form concrete or masonry with aggregate of relatively hard materials, such as granite or the like. Such material creates problems, of screw type anchors of the prior art being unable to penetrate the walls of the bore, or very large torque requirements being necessary to
20 embed the threads into the walls. It should be understood that the term masonry used herein is intended to be generic to stone-like building materials and includes but is not necessarily limited to, concrete, brick, fire brick materials, ceramic materials, etc.
   It has been found that, even within the crowded art of threaded fasteners, a unique relationship between the several parameters of a threaded fastening system in concrete or
25 masonry exists which will permit such a system to work effectively and efficiently in hard aggregate concrete.
   According to this invention, a method of securing a screw-type anchor in hard aggregate masonry material includes the steps of accurately forming a bore of predetermined diameter in the masonry, and screwing the screw type anchor into the bore so that it penetrates the side
30 wall of the bore by axially inserting the anchor with a rotational speed not exceeding 250 RPM at torque levels not less than 150 in.lb (1700 cmN).
   A particularly effective fastening for use with the method of this invention is described and claimed in our patent specification GB-A-2115511 from which the present case has been displayed.
35 The accompanying drawings illustrate a method in accordance with this invention. In these drawings:—
   Figure 1 is a side elevational view in partial section of an anchor in a bore in masonry;
   Figure 2 is a partial, enlarged sectional view taken axially of the anchor and bore; and
   Figure 3 is a view similar to Fig. 2 but with an alternative embodiment of the anchor.
40 A preferred form of anchor for use with the present invention will first be described. The anchor shown in Fig. 1 is a threaded fastener 10 having an elongated shank which includes at least one thread 12 formed thereon. The thread, as will be shown later herein, is created with a predetermined helix angle, pitch and included angle, and includes a sharp pointed crest 16 creating a crest diameter of predetermined value. The first step in the method of securing the
45 fastener 10 is the formation of a bore 26 of predetermined diameter in a relatively hard aggregate concrete or masonry structure 24. The parameters and dimensions of the system will be described in detail later herein but it should suffice to say that the system is ultimately designed to in some way clamping or fixingly associate a fixture or attachment device 28 to the hard aggregate concrete structure 24.
50 The threaded fastener 10 further includes a relatively sharp point 13 to facilitate entry into the bore and also includes some form of rotation inducing surfaces on a driving head 14 to enable a user to threadingly insert the fastener in the hard aggregate material, through the application of torque with known tools.
   In the development of this invention it has been found that the included angle of the thread
55 form 12 of the fastener is an important consideration in the design of the total system. A thread form 12 with a sharp apex 16 should create a V-shaped thread cross-sectional configuration with the flanks of the thread intersecting at an included angle, shown in the drawings as A_2, which should be in the range of 50° to 65°. With this rather large included angle of the thread, the thread has sufficient durability and strength to penetrate hard aggregate material, as
60 compared to the rather sharp-crested 30° to 40° threads which have been suggested for use in conventional aggregate materials. The selection of the thread angle A_2 is one of the vital parameters in this threaded system, in that the thread angle must be so small, and the thread thus weak, as to be mutilated or bent when applied and permit little or no penetration in hard aggregate material, nor so large as to require installation torques that are excessive and
65 which could lead to torsional failure of the anchor.

A further important parameter in the design of the is the thread helix or lead angle which is shown as A_1 in Fig. 1. It has been found that this angle A_1 should be in the range of 6° to 8.5°. This range for the helix angle parameter has been found to be sufficient in the hard aggregate material, it has further been found that if the helix angle is smaller than 6° the fastener has a
5 tendency to strip or deform the threads created in the bore. Even though the fastener threds may be able to penetrate the concrete or masonry, the combined rotative or axial forces of the fastener on the concrete may create excessive pressures on the thread formed in the concrete, causing the internal thread to crumble, and eliminate the threaded engagement. Conversely if the helix angle is greater than 8.5° the torque to embed the fastener in the concrete will be too
10 great for normal commercial applicating equipment and could possibly lead to torsional failure of   10 the anchor.

A third important relationship, in a system designed to enable an anchor to penetrate and hold in hard aggregate material, is the extent of penetration of the crest 16 of the thread 12 of the fastener. A particular relationship between the crest diameter D_1 and the bore diameter D_2
15 has been found to be highly desirable in conjunction with the above two parameters, namely,   15 the included angle of the thread and the helix angle. It has been found that if the depth of engagement "d" shown in Fig. 2 is substantially 0.05 times D_1 (crest diameter) then the combination effect of the unique relationship of the specific parameters "d", D_1, D_2, A, and A_1, will not only permit the threaded fastener to be engaged tightly within the hard aggregate walls,
20 but will permit the fastener to be driven without mutilation or harm to either the concrete   20 structure or to the threads. While it may appear that a much greater engagement is required for maximizing the effectiveness of the fastening system, it must be understood that such a maximum depth of engagement may not at all be feasible or practical, since it is to be accomplished using relatively standard thread engagement techniques which may require
25 abnormally high torque. Thus it has been determined that the penetration value of 0.05 times   25 D_1 provides a reliable completed fastening system within the requirements of presently available materials for fasteners and applicating machine technology. It should thus become apparent that the fastening system is desirably designed so that the bore diameter D_2 is substantially 0.9 times the value of the crest diameter D_1.
30 A further parameter of the system which has been found to be important is the number of   30 pitches of threads that are embedded in the concrete, i.e., essentially the axial penetration of the threaded shank into the bore. It has been found that at least 6 pitches of such an embedded thread in a system designed with the above parameters is desirable to provide acceptable pull-out strength of the anchor.
35 The threads per unit length design parameter, while related to the lead angle A_1, is also   35 included in specific examples of fastening systems designed in accordance with this invention. It has been found that the optimum threads per unit length value, as well as the helix angle value, decrease as the nominal diameter of the fastener increases.

Specific examples of fastening systems for use with this invention are as follows:

~7/32 inch (0.210 inch; 0.533 cm) __Nominal anchor diameter__

Crest diameter   0.210 inch (0.533 cm)

5 Helix angle   7.8°

Depth of thread engagement   0.01 inch (0.025 cm)   5

Threads per inch   11 (4.3 per cm)

10 Thread included angle   60°

                                                                           10

1/4 inch (0.250 inch; 0.635 cm)   __Nominal anchor diameter__

Crest diameter   0.250 inch (0.635 cm)

15 Helix angle   7.25°   15

Depth of thread engagement   0.0125 inch (0.032 cm)

Threads per inch   10 (3.95 per cm)

20 Thread included angle   60°   20

5/16 inch (0.313 inch; 0.795 cm) __Nominal anchor diameter__

25 Crest diameter   0.313 inch (0.795 cm)   25

Helix angle   7.20°

Depth of thread engagement   0.016 inch (0.041 cm)

30 Threads per inch   8 (3.15 per cm)   30

Thread included angle   55°

35 3/8 inch (0.375 inch; 0.952 cm) __Nominal anchor diameter__   35

Crest diameter   0.375 inch (0.952 cm)

Helix angle   6.9°

40 Depth of thread engagement   0.020 inch (0.051 cm)   40

Threads per inch   7 (2.75 per cm)

Thread included angle   55°

45   45

The reasons for the unique effective relationships between the parameters noted above are not entirely known, but it is believed that it is a combination of the parameters to provide the optimum surface engagement between the threads and the masonry or concrete without
50 substantially increasing the torque requirements and maximizing the pull-out strength of the   50
complete joint.
The root diameter D_3 must also be a part of the complete dimensioning of the system, and it has been determined that a relationship between crest diameter D_1 and the root diameter D_3 should be such that D_3 is substantially 0.75 times D_1 to provide the necessary space between
55 the threaded fastener 10 and the walls of the concrete bore 26. The dust or debris 30   55
developed during the embedment of the fastener also creates an important ingredient in the fastening system, and the distance between the root diameter D_3 and the bore diameter D_2 must be designed to collect the dust and to provide a sufficient amount of compaction of the dust which acts as a secondary frictional securement force within the system.
60 The method of installing such fasteners in hard aggregate masonry also includes controlling   60
the rotational speed and torque applied to the anchor whilst it is screwed into the bore. Typical rotational speeds of equipment generally used in the driving threaded fasteners or in hammer drills are in the neighbourhood of 1500 RPM. It has been found that when anchors are driven at speeds and torques which would be considered in the art as low speeds and high torques, for
65 example at a rotational speed not exceeding 250 RPM in conjunction with torque generally not   65

less than 150 in.lb (1700 cm N) the anchor is properly secured.

Turning to Fig. 3, an alternative embodiment of fastener is shown wherein like reference numerals designate like elements with the addition of the "prime" notation. In this embodiment a second helical thread 20' is shown to be positioned intermediate the turns of the primary
5 thread 12'. This thread 20' has a v-shaped cross-sectional configuration with the flanks of the second thread intersecting at a much sharper included angle shown as A'. Preferably this is in the range of 30° to 50°. With this smaller included angle the amount of dust or concrete debris 30 can be maximized and yet provide a stabilizing influence in the system by centring the device and thus maximizing efficiency and effectiveness of the total system described above.
10   While many of the parameters above for the specifically designed systems may be found individually in some prior art threaded devices, it is submitted that the specific parameters for driving the fasteners produce a new and unexpected result in the embodiment of threaded fasteners in hard aggregate concrete.

15 CLAIMS
1. A method of securing a screw-type anchor in hard aggregate masonry material including the steps of accurately forming a bore of predetermined diameter in the masonry, and screwing the screw type anchor into the bore so that it penetrates the side wall of the bore by axially inserting the anchor with a rotational speed not exceeding 250 RPM at torque levels not less
20 than 150 in.lb (1700 cmN).
2. A method according to claim 1, wherein the screw-type anchor has a thread crest diameter such as to provide a bore diameter/crest diameter relationship of substantially 0.9 to 1.
3. A method according to claim 1 or 2, wherein the helical angle of the thread on the
25 anchor is in the range of 6° to 8.5°, and the flanks of the threads intersect at an included angle of 50° to 65°.
4. A method according to any one of the preceding claims, wherein the anchor is screwed into the bore a distance of at least 6 pitches.
5. A method of installing a screw anchor substantially as described with reference to the
30 accompanying drawings.

CLAIMS

Amendments to the claims have been filed, and have the following effect:—
Claim 5 above has been textually amended as follows:—
35 5. A method substantially as described with reference to the accompanying drawings.